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## Forest fires

## Heat and light

Sep 4th 2003

From The Economist print edition

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AP

**The technology of monitoring and predicting forest fires is getting better, and the PDA could become the fireman's latest weapon**

SO FAR this year, some 2½m hectares (6m acres) of North American forest have been consumed by fire, and several fires are still blazing in the west of the continent. The United States' Forest Service reckons it will spend around \$900m in 2003 on putting fires out, and the damage such fires have caused probably cost several times that figure. A long drought, high winds and extraordinarily high temperatures have also created tinder-box conditions in Europe, where fires have destroyed at least 500,000 hectares of forest and killed more than 30 people.

Accurate systems for monitoring fires would therefore have enormous value. If such systems could predict how a wildfire was likely to behave, that would be even better. It would enable those in charge to decide which areas should be evacuated, and how to deploy fire-fighters and their equipment.

Such systems, fortunately, are starting to take shape. The ultimate objective is something that can take data from sensors near and far, process them through suitable computer models, and give those in charge of dealing with a fire a running commentary on how they might best go about it. The technology to do that is not all there yet. But it is getting closer.

Fires depend on fuel, in the form of the plants they burn. Among the tasks of Earth-

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observation satellites currently in orbit are to assess how combustible that fuel is by measuring its moisture content, and to provide regular updates of conditions in areas that might be at risk from fire. Three such satellites, *Landsat-7*, *EO-1* and *BIRD*, provide detailed but infrequent reports. Two others, *Terra* and *Aqua*, monitor conditions more often.

If a fire does break out, data from these satellites can be combined with information about the weather in order to estimate how fast the fire is likely to spread. At that point *Terra* and *Aqua* are used to monitor the fire. They are equipped with instruments sensitive to heat radiation, allowing researchers to map the extent and intensity of a fire and to estimate the altitude of the smoke plumes from it. These data are made available on the internet within two hours or so of a satellite passing over a fire.

This is a good start. But according to Julie Haggerty, of America's National Centre for Atmospheric Research (NCAR), in Boulder, Colorado, the resolution of *Terra* and *Aqua* is often too poor to characterise fires in detail. Also, their orbits mean that each of them can look at any given spot on the Earth's surface only twice a day. A lot can happen in the intervening hours.

NASA, America's space agency, hopes to rectify these deficiencies by developing a "sensor web" system of fire-monitoring satellites that can communicate with each other. A satellite which detected a fire starting would signal another to take more detailed pictures of what was going on.

That would be an improvement. And yet satellites, though able to give the big picture, are too far away ever to be able to provide enough detail. One way around this, say Chris Justice, a fire researcher at the University of Maryland, would be to use piloted aircraft instead. A suitable vehicle could hover over the same spot for an extended period. NASA, which is experimenting with such unmanned vehicles, hopes to place them in the sky for months at a time, to keep watch during the entire dry season.

## Blazing a trail

Satellites and aircraft, of course, can only record what is going on. They cannot say what is likely to happen in the future. For that, computer models are needed.

FARSITE, a widely used model invented by Mark Finney of the Forest Service's Fire Sciences Laboratory in Missoula, Montana, takes into account a site's topography, the fuels available, and the weather, to show how a fire is likely to move across the countryside. More sophisticated models still under development, such as one created by Rodman Linn and his colleagues at the Los Alamos National Laboratory in New

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Mexico, can also simulate the interaction between a fire and the air around it. And Michael Bradley and his team at another national laboratory, Lawrence Livermore, have linked this model to a weather-forecasting package. Although scientists are still unable to model a "no-advance-notice" fire faster than it actually unfolds in nature, their models should soon be capable of predicting the behaviour of "prescribed burns"—deliberate scorplings started by forest managers to burn off undergrowth.

The inability of models to handle true wildfires is partly due to their inherent limitations. According to Dr Finney, however, a lack of good data presents a more serious problem than such technical limits. Better models require better data, but forest fires are not easy research subjects.

What is needed, according to Joshua Wurman, a researcher at NCAR, are detectors that can monitor a fire at close range. In July, he and his colleagues planted a lorry-mounted radar, dubbed "Doppler on Wheels", about 3km from a forest fire that was burning near Montana's Glacier National Park. Mobile Doppler radars were originally developed for the study of hurricanes and tornadoes. Dr Wurman's version can map the three-dimensional structure of the smoke plume from a fire, and also the winds around that fire. If such data were plugged into an appropriate computer model, such as Dr Linn's, it would be possible to make a fair stab at predicting sudden shifts in wind caused by the fire itself. That would be important information, since such winds can drive the flames in new directions. Having shown that Doppler radar works on fires, Wurman and his team are exploring ways of channelling the data from the radar into models fast enough for the predictions to be useful.

## Integral trees

Although better monitoring technologies are changing the nature of fire analysis, Richard Wagoner, the project director of NCAR's Wildland Fire Research and Development Collaboratory, reckons that integrating their observations would make them still more effective. Mr Wagoner and his colleagues are trying to create a system that will swallow and digest disparate data from satellites, aircraft and ground-based sensors, and run them through suitable models. The results would be distributed, with the aid of wireless technology, to firemen carrying personal digital assistants at the time of a blaze. A prototype, says Mr Wagoner, will be available next year. It should help firemen to predict the behaviour of wildfires a few hours in advance.

Sadly, though, none of these models takes into account human factors. According to Jesús San-Miguel-Ayán, who co-ordinates the European Forest Fire Information System, about 95% of fires in Europe are caused either intentionally or by careless human action. Many damaging fires this summer, he notes, were the result of arson. This complicates the task of predicting areas at risk, because researchers must consider not just vegetation maps, but unemployment statistics, agricultural practices and local habits. These are even harder to handle than moisture contents and wind velocities. The science of fire-prediction has some way to go yet.



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